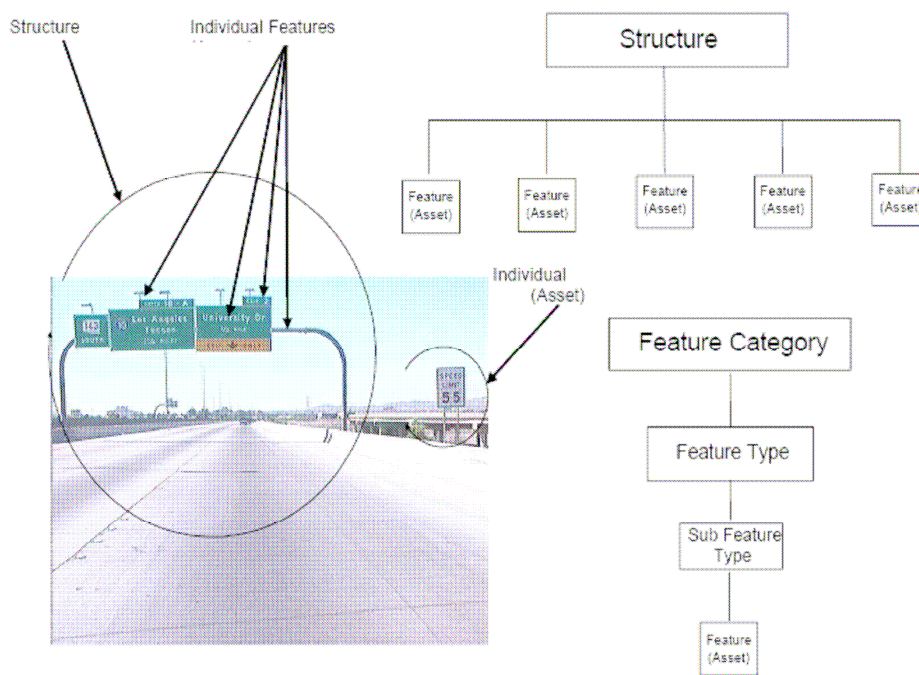


RESEARCH IMPLEMENTATION REPORT 2005



FROM: PROJECT
SPR-474,
*Development of a
Statewide GIS-
Based Features
Inventory System
(FIS)*

ARIZONA TRANSPORTATION RESEARCH CENTER

MARCH 2006

Arizona Department of Transportation



Welcome

The Arizona Transportation Research Center (ATRC) is proud to present the 2005 Research Implementation Report—our third annual report on implementation. Research results have assisted the State of Arizona's transportation needs for two decades. Documenting these results in a formal document helps ATRC and the Arizona Department of Transportation (ADOT) Research Council focus more accurately on future transportation research needs.



The ATRC research program continues to span a wide breadth of topics, from complex engineering issues to environmental and administrative research. Research implementation in six of the seven ATRC research emphasis areas is highlighted in this report.

To gain the greatest value from the research performed it is important to evaluate and learn from the results of the research. This maximizes the benefits of completed research and improves the selection and design of future research efforts. ATRC staff monitor the implementation of all completed research projects. Potential implementation is considered for all research proposals reviewed by the Research Council. As a project progresses, the technical advisory committee (TAC) for that project continues to evaluate potential implementation of the research. Finally, at the completion of each research study implementation is again the primary focus of the TAC and the Research Council. Through this process we hope to improve the research program through the feedback gathered during implementation monitoring.

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About the Arizona Transportation Research Center

The Arizona Department of Transportation (ADOT) conducts research on a wide range of transportation topics. The Department's research effort is administered by the Arizona Transportation Research Center (ATRC), which has immediate responsibility for the management and conduct of research. During 2005 the ATRC research program was guided by the Research Council, which provided direction on research priorities. The research Steering Committee provides policy guidance for the total research effort.



The Arizona Transportation Research Center is located at 2739 East Washington Street, Phoenix, Arizona.

ATRC STAFF

Mihret (Mercy) Daniel – Library Technician
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John Semmens – Research Project Manager
Dale Steele – Librarian

ATRC manages the ADOT transportation research program, including conducting in-house research, coordinates the ADOT product evaluation program, houses and operates the ATRC Library, and provides direct financial support for ADOT's Local Technical Assistance Program (LTAP).

Each year ATRC solicits research proposals throughout ADOT and the transportation community. In meetings with individual offices or in Department-wide needs assessment meetings, ADOT personnel are asked to suggest research pertinent to their areas. ATRC also invites suggestions from academia, consultants, and industry. Research suggestions are solicited through personal contact, newsletters, electronic communications, and the Internet.

The ATRC research program is currently grouped into seven emphasis areas. These areas are:

- Environment
- Intelligent Transportation Systems (ITS)
- Maintenance
- Materials and Construction
- Planning and Administration (including Motor Vehicles, and Information Technology)
- Structures
- Traffic and Safety

New projects are assigned to one of these areas. A project manager is assigned to each project. Technical advisory committees are formed for each project to work with the project manager on developing work scopes, reviewing and guiding the progress of the research, and reviewing the final report.

Small Budget Projects

The Arizona Transportation Research Center integrates opportunities for university students and small consulting firms into its research program. Each year ATRC allocates up to \$100,000 for small budget projects (\$15,000 or less) that often provide opportunities to contract university students and small consulting firms for transportation research. ATRC enthusiastically encourages future transportation professionals and small business. This strategy provides opportunities for individuals to learn first hand about the role of research and technology in the Nation's transportation system, and the variety of available transportation career or business options. The results have been high quality research that makes effective use of the ATRC research budget while providing valuable professional experience for students and small businesses.

Research Implementation

Implementation may range from assisting an entity in making a decision, to a change in operational strategies or activities. Implementation of research results often occurs over a period of several years. As such, implementation that occurred during 2005 will be addressed in this report, including actions associated with projects completed prior to 2005. The discussion is grouped by research emphasis area.

Implementation during 2005 includes improvements in ADOT's environmental management systems, critical statewide emergency communication system improvements, application of sophisticated computer systems to maintenance activities and traffic systems, and the application of cutting-edge technology in bridge construction.

Completed Projects

During calendar year 2005, 16 research projects were completed under ATRC management. (Appendix A includes a list of these projects.) All these projects are examples of applied research. As such, implementation of the research results is the ultimate measure of the success of the research.

Knowledge is not achieved until shared.

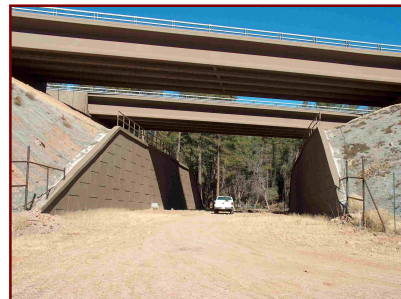
ENVIRONMENT

SPR-540: *Evaluation of Measures to Minimize Wildlife-Vehicle Collisions & Maintain Wildlife Permeability, Arizona State Route 260*

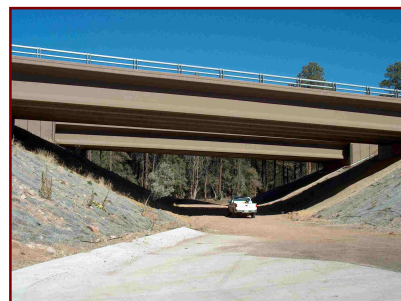
Project Cost: \$546,160

Summary: This project began in 2002. It evolved into a two-phase study which is expected to be completed during 2006. This research addressed the impact of a major highway reconstruction project on wildlife. It evaluated a suite of measures being implemented by the Arizona Department of Transportation to maintain wildlife permeability across the highway and reduce the incidence of wildlife-vehicle collisions. State Route (SR) 260 is being upgraded in five phases. It will incorporate 11 wildlife underpasses and six bridges, as well as ungulate-proof fencing. The effectiveness of these roadway features in achieving the study objectives is being evaluated. Other objectives include:

- Evaluate highway permeability and wildlife movements across SR 260 among construction classes (pre-, during, post-construction) using Global Positioning Satellite (GPS) telemetry.
- Characterize the temporal and spatial patterns of wildlife-vehicle collisions and changes associated with highway reconstruction (pre-, during, post-construction), and compare wildlife-vehicle collisions and GPS-determined crossing patterns.
- Assess and compare wildlife use of the first two wildlife underpasses constructed along SR 260, and evaluate the efficacy of video surveillance as a means to assess wildlife use on other underpasses.



Implementation: In addition to its scope in addressing conflicts with wildlife, the SR 260 project is noteworthy for two other aspects: its phased construction, and application of adaptive management. This phasing of the highway upgrade in five separate sections has facilitated effective construction oversight by ADOT and allowed construction to occur on priority sections. The incidence of wildlife-vehicle collisions was a key factor used in the planning and prioritization of the order in which highway sections have been upgraded.



The phasing of construction along SR 260 has also facilitated the feedback of the preliminary findings to ADOT project managers which have been used to address wildlife-related issues. Preliminary insights have been applied on SR 260 sections

already under construction or planned for construction to improve wildlife passage structures, identify appropriate stretches of SR 260 needing ungulate-proof fencing to maximize underpass effectiveness and minimize wildlife-vehicle collisions, and select appropriate sites for other measures (e.g., wildlife escape jumps and gates). Though such an adaptive management approach can yield continuous improvement to the quality of highway construction, especially relating to highway safety, it does come at a potential cost if they result in construction delays and increased project budget expenditures. Continuous contacts between the research team and ADOT engineers allows for aspects of the preliminary findings in the research to be evaluated and incorporated in subsequent project plans and designs by the department.

SPR-543: *Strategies to Integrate Environmental Stewardship into ADOT's Business*

Project Cost: \$99,380

Summary: Project SPR-543, *Strategies to Integrate Environmental Stewardship into ADOT's Business*, was initiated in July 2003. The primary objectives of this research were to qualitatively evaluate the environmental performance of ADOT and to identify opportunity areas and strategies for improving environmental performance. The research was conducted by Wayne Kober, Senior Environmental Management Specialist, serving as a consultant for the American Association of State Highway and Transportation Officials (AASHTO) Center for Environmental Excellence.

Implementation: The project report was published October 2004. Earlier in the year the project technical advisory committee reviewed the many recommendations and developed a matrix of key issues for the agency to explore based on those recommendations. ADOT executive management immediately put together an implementation committee (the Environmental Management and Compliance Steering Committee - EMCSC) to determine and recommend ways that the agency can proceed with implementation. This committee met regularly under the watch of committee chair Sonya Herrera, Health & Safety Administrator. Transportation Planning Division director Dale Buskirk and the State Engineer office are working closely with the team.

Recommendations on an organizational structure for Environmental functions was presented to and accepted by ADOT Management. Action Plan based on these recommendations was released by ADOT management in 2005. Implementation of that action plan resulted in the establishment of the office of Director of Environment, responsible for and bringing together all ADOT Environmental functions.

Specific recommendations adopted by the ADOT Core Team include:

- Adopt environmental ethic for ADOT
- Adopt new environmental structure for ADOT to meet organizational objectives [Establish office of environment, reporting to the state engineer].

- Identify and address the need for additional resources for expanded environmental services.
 - Ensure consistency of environmental compliance across the organization.
 - Clarify and articulate respective missions and roles for environmental responsibilities.
 - Focus stewardship on compliance in the early years.
-

INTELLIGENT TRANSPORTATION SYSTEMS

SPR-473: Arizona Intelligent Vehicle Research (Phase 5 - Long-Term Evaluation)

Project Cost: \$65,030

Summary: This Intelligent Vehicles (IV) project was the result of ADOT visits to the National Automated Highway Systems (AHS) Demonstration in San Diego, California in 1997. The project concept is to evaluate Intelligent Transportation Systems (ITS) driver assistance and guidance technology for maintenance vehicles in severe winter storm conditions. The Arizona Transportation Research Center (ATRC) is conducting this project in-house. Six winters of testing and evaluation have now been completed. Phased project reports were published by ATRC in February 2001, May 2002, September 2003 and January 2004. ATRC continues to monitor implementation and field evaluation of installed IV snowplow warning systems. Additional warning devices are being evaluated for the 2005-06 winter.

Implementation: The current implementation involves a field evaluation of new Eaton backing-warning systems on four trucks at Kayenta, Kingman and Tucson between October 2005 and May 2006. This evaluation also will compare these radars with rear-view cameras installed on seven vehicles in Tucson District, and planned for Kingman.

SPR-561: Transportation Communications Interoperability Phase 1- Needs Assessment

Project Cost: \$40,000

Summary: Communication is the key to all ADOT operations and emergency response roles in both rural and urban areas of Arizona, from daily maintenance to events to incidents to regional security issues. Currently no single radio frequency allows for all responder groups to talk to each other. A critical need exists for secure cross-channel communications, on the present radio systems, both within ADOT and with its transportation agency and emergency response partners of all levels. Radio interoperability technology can overcome the lack of a common frequency, channel, or system between response team agencies, and across jurisdictional boundaries. The

Phase 1 communications systems research project addressed current specific challenges of radio interoperability for ADOT and for its transportation-agency partners.

Implementation: Of five key recommendations, three were implemented by the ADOT Intermodal Transportation Division either as running process changes or system expansions. Two additional pilot projects were proposed for Phase 2 of this study, which is funded as project SPR-569, *Transportation Communications Interoperability Phase 2- Resource Evaluation*. Project SPR-569 was initiated in mid-2005.

SPR-562: ITS Program Acceptance in Elderly Communities

Project Cost: \$30,843

Summary: The proportion of the population over 65 is expected to double by 2040. Elderly drivers are an increasing element of the population, and with advanced age come increasing challenges to safe and efficient travel, and overall mobility for the individual. As the proportion of elderly citizens increases, it will be important to take advantage of every opportunity to enhance the driving ability of older drivers. Research has been conducted nationally into the needs of the elderly for Advanced Traveler Information Systems (ATIS), as well as the special characteristics of the elderly that may impact Intelligent Transportation System design and deployment. However, very little research has been conducted into the elderly community's reaction to such overall ITS program implementations as ADOT has deployed in metro Phoenix (Closed Circuit TV cameras, Variable Message Signs, traffic detection, signal coordination, ramp metering, the national 511 system, and web-based traveler information). If ITS is planned and deployed effectively with regard to the concerns and limitations of the elderly drivers, the potential increase in roadway safety could be quite significant.



Implementation: Both formal and informal project recommendations were implemented by ADOT during the course of the project as new releases of the AZ511 website were developed. Recommendations are also being factored into the scope of the new rural ITS corridor management project SPR-615, *ITS Concepts for Rural Corridor Management*.

SPR-570, Rural ITS Progress Study - Arizona 2004

Project Cost: \$60,000

Summary: In December 1998, ADOT completed Research Project SPR-457, *Strategic Plan for Statewide Deployment of ITS* (Intelligent Transportation Systems). Since Arizona's statewide ITS design was completed, there has been an extensive deployment of the most critical systems in the plan. The next step was to evaluate the key ITS concepts and hardware that are being used in rural Arizona on a wide scale.

Implementation: The ADOT Transportation Technology Group and several Districts requested that a second phase, state-of-the-practice study be conducted to identify the latest successful technologies in several core rural ITS systems, and to evaluate alternative business models for system or data ownership in future deployments. This led to the follow-on research in project SPR-615, *ITS Concepts for Rural Corridor Management*.

MAINTENANCE

SPR-474: Development of a Statewide GIS-Based Features Inventory System (FIS)

Project Cost: \$175,000

Summary: This project was designed to recreate the Feature Inventory database because the existing system was no longer useful in the form it was in. The decision was then made to recreate the database using Microsoft Access and to repopulate the database with new data. In addition to the operational problems with using the existing database (prior to modification), staffing reductions have precluded continuous updating of the newer features. This has led to the dilemma of owning an expanding system in real growth while the data indicates a stagnant system. To overcome this, it was necessary to develop a process that could easily update roadway features that currently do not exist in the database and that can be used to maintain the database so that it is always current. This could consist of the use of remote sensing techniques, field global positioning satellite (GPS) units, etc. The usefulness of any roadway feature system is predicated upon its ease of use and how well it communicates or presents the information contained within it. The use of geographical information system (GIS)-based systems enhances the ability to display and use data.

Implementation: Based on this research the Features Inventory System (FIS) database has been built and categories, features, sub-features and attributes have been defined. Currently, the implementation focuses on populating the database. The State Engineer's Office has launched a project goal to get the complete State inventory data into the system. A business Project Manager will coordinate with many groups and

different interests, making policy and procedural decisions, allocating resources, and securing funding.

ADOT Maintenance has purchased 21 Trimble Global Positioning System (GPS) units to begin assisting with this effort. An in-house FIS Trimble/Pocket PC Software application has been developed to run on the Trimble and iPAQ Pocket PC that will allow the users to easily update and transfer data back and fourth between the Trimble/iPAQ and the FIS database. This software has the ability to capture GPS coordinates as part of the collection process. These data/GPS capturing capabilities have been developed using open technology (Windows CE platform & MS development tools). The immediate target hardware is Trimble and iPAQ, but may as well be anything else that runs Windows CE.

Some of the traffic signs data has been entered into the FIS database. Data collection of more traffic signs and other highway features is expected to begin by early summer. The Central Maintenance Office has recently hired a project manager and will hire three technicians for the FIS data collection project.

SPR-494: Enhance the Pavement Management System so that It Can Determine Preventative Maintenance Strategy Effectiveness

Project Cost: \$273,300

Summary: The Arizona Department of Transportation (ADOT) pavement management system (PMS) is used to allocate expenditures on pavement preservation. Data is collected annually on roughness, skid, cracking, rutting and flushing. This data is entered into the PMS system to allocate resources and to provide input into the pavement design function. One of the data fields that the PMS uses in project selection is the average maintenance expenditure per year. This study was designed to develop a system that allows evaluation of the outcomes of maintenance activities so that their cost effectiveness can be determined and used in development of pavement preservation strategies.

Implementation: The outcome of the research project is the Highway Pavement Management Application (HPMA) software. The software has currently been implemented and used on daily basis by Pavement Management Section in the ADOT Materials Group. The application is used in assisting pavement management engineers to develop statewide pavement preservation program. Another HPMA training was held for pavement designers in October 2005. Another HPMA training will



be held in March 2006 for district maintenance personnel. The ultimate goal of the trainings and other implementation efforts is to make the system available to most maintenance personnel (mainly in Districts), assisting them in determining preventative maintenance strategy effectiveness.

PLANNING AND ADMINISTRATION

SPR-486: Highway Facilities for an Aging Arizona Population

Cost: \$15,055.80

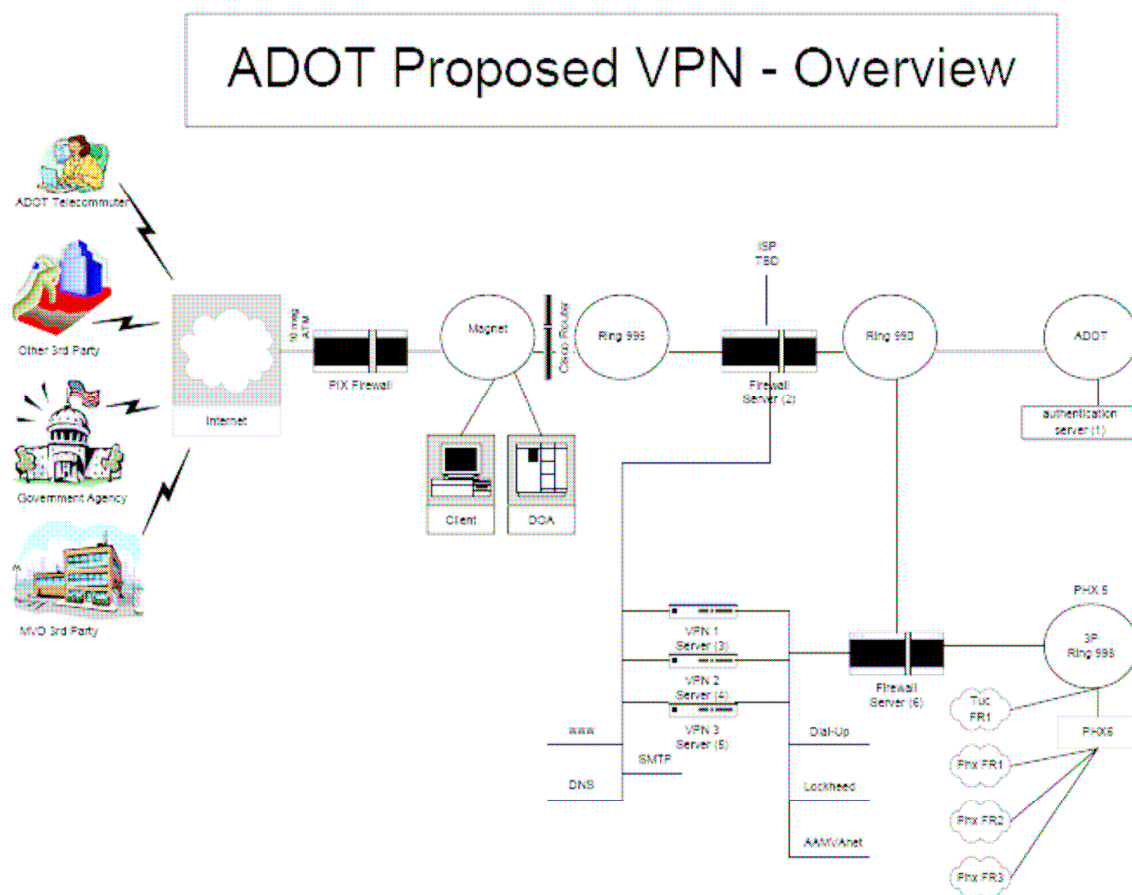
Summary: The purpose of this research project was threefold: to examine the current knowledge of state-of-the-art highway design practices aimed at increasing the safety of older drivers; assess the crash and fatality data for older drivers in Arizona; and survey older adults regarding their perceptions of Arizona's roadways and possible needs for enhancement. Older adults increasingly make up a larger part of the driving population. Age related declines and complications from medical conditions put older drivers at higher risk of collision, and when in collision, of a fatal injury. Changes in visual acuity, cognition, use of certain medications, and functional impairment may contribute to reduced driving ability. In Arizona the study found that, like older adults nationwide, older drivers were more likely have angle and left-turn collisions, to be in collisions involving intersections and junctions, at signaled and unsignaled left-turn intersections, and in daylight hours. Older adults surveyed rated driving at night as very difficult, followed by driving on a freeway and identifying street names, feel improvement could be made to lettering for roadway signs, intersection markings and signals, and support increasing the availability of sidewalks. Survey respondents most frequently rated larger and better-illuminated traffic signs as the most helpful design improvement that could be implemented and most frequently rated special senior driver testing programs as most the most effective screening and assessment option.

Implementation: The research report was used to support an application for a demonstration project funded by the FHWA. Two sites were considered: SR 95 within Bullhead City and US Route 60 within the incorporated retirement community of Sun City between mileposts 147.1 and 148.2. US Route 60 was selected. Design enhancement options included: Better street name signing, Roadway alignment to provide a non-skewed intersection, "Left Turn Yield on Green Ball" signing, "Turning Traffic Must Yield to Pedestrians" signing, "One Way/Wrong Way" signing, Modification of crosswalk indication, and to 2.8 ft/sec, and Pedestrian crosswalk control placard. The demonstration project was funded by the FHWA. The evaluation of results is underway.

SPR-502: ADOT Uses for Virtual Private Networking Technology

Cost: \$55,345.00

Summary: This project was initiated to assess the possibility of using modern Virtual Private Networking technology as an additional means for access into ADOT user-based services for records retrieval and management. Two phases of the project were defined early in the planning stage. Phase 1 of the project included the feasibility study for the use of Virtual Private Network technology by ADOT, and especially by the Motor Vehicles Division (MVD) of ADOT. Following the feasibility study period, preliminary analysis was conducted to determine potential users of VPNs for access to MVD records in cases where no other connectivity is possible or the costs of such connectivity are prohibitive. Phase 2 of the project included the final report and recommendations following field-testing Virtual Private Network (VPN) technology by ADOT, and especially by the Motor Vehicles Division (MVD) of ADOT. From the results gained by the study and from the levels of satisfaction expressed by the users, VPNs were deemed a viable option for ADOT to offer both remote access and LAN-to-LAN connectivity to ADOT systems and information resources, and are recommended for full roll-out to all appropriate parties.



Implementation: VPN has been fully implemented at ADOT. Eight ADOT branch office locations were converted from 56k circuits to DSL connections. DSL speeds are 256KB/sec, 512KB/sec or 1MB/sec. The number of users per location ranges from 5 to 20. All branch office VPN connections are actively being used during normal business hours each day. All offices have been working quite well since implementation. No major problems have come up. Minor network issues arise, which are normal within a non-DSL connection. ADOT is very satisfied with the results of this implementation.

SPR-515: Program and Project Financial Management Needs Assessment

Cost: \$139,978.00

Summary: This report focuses on improving project budgeting, accounting, and reporting for ADOT. The project was conducted in five tasks: Initiate Project, Document Requirements, Survey Project Financial Management Best Practices, Analyze Alternatives and Recommend Options, and Develop Preferred Option Implementation Plan. The report presents requirements for improving the financial controls and reporting for ADOT projects. Four financial improvement projects were recommended to address the needs of ADOT. For projects that had technical alternatives, the alternatives are presented with a recommended approach. Dye Management Group conducted a literature search and a survey of practices employed by other transportation organizations to support project budgeting and accounting. The best practices information obtained from this effort contributed the recommended solutions to improve ADOT's financial information. The final chapter is an implementation plan for the preferred alternatives. The four financial improvement projects recommended in the study are: Budget Processes and Architecture, Budget and Financial Reporting, Financial Policies and Procedures, and Financial Training. The implementation plan identifies tasks and subtasks required to complete each project.

Implementation: ADOT Financial Management Systems developed a phased approach to implementing feasible recommendations with a favorable benefit/cost ratio. Specific implementation actions include:

- *Improved programming decisions* – Significant progress has been made on this issue. A new table (PBIF) was created in the ADVANTAGE financial system to allow multiple budget sources on one project. Also, the *Original Budget Amt* on PRBL screens can be modified to reflect changes in programmed amounts prior to project award. The automated PM form can access budget information contained with PBM (Program Budget Management).
- *Improved accountability* – ADOT policy *FIN 9.06 Project Numbers – Project Numbers Assignment – Project Number Reference Report* was revised in December, 2005. It provides direction on using the new Automated Project Master Form and shows a logical progression of how projects are assigned and tracked.

- *Improved user productivity and satisfaction* – This is an ongoing effort. The ADOT data warehouse is now being used to track project related changes (budget increases, task orders, modifications, etc.). The goal is to eventually integrate PBM as part of the data warehouse for improved reporting and tracking abilities.
- *Reduced effort* – PBM is being used for this. Currently the system is still in the testing and debugging phase and is being run concurrent with spreadsheets. The goal is to eliminate spreadsheets starting with FY2007.
- *Improved financial control* – There is an ongoing effort to improve the accuracy of financial data so that information is consistent across various systems. The ability to modify and improve data in the ADVANTAGE financial system will allow users better reporting and tracking of budgeted amounts and available balances.

SPR-568: Arizona Highways Magazine's Impact on Tourism

Cost: \$15,924.48

Summary: The purpose of this study was to: (1) examine the affect of Arizona Highways Magazine (AHM) on tourism to and in Arizona; (2) determine trip characteristics of AHM subscribers traveling in Arizona; and (3) calculate a benefit/cost ratio for AHM based on the magazine's cost and revenues as well as the value-added economic impact due to it's influence on travel. Findings suggest that a very high percentage of AHM subscribers have taken trips in Arizona over the past five years, with many visiting multiple times. Further, many in-state subscribers have taken day trips in the state in the same time period, again often multiple times. Most out-of-state subscribers stay for about a week when they visit, most often traveling with a spouse or partner. In-state subscribers are much more likely than other groups to travel with friends. Almost half of out-of-state subscribers stay in a hotel/motel while on their trips in Arizona, but quite a high percentage stay in a private home (friend or relative). Out-of-state subscribers are very likely to visit friends and family during the visit (about two-thirds), but they also drive to view scenery, engage in natural area activities as well as cultural heritage activities, and shop. Subscribers in general can be considered "product involved" when it comes to Arizona as a travel destination; they have very positive perceptions of the state as a destination and are very interested in learning more about it. Subscribers use AHM fairly extensively as a source of travel information. They report the magazine has substantially increased their interest in Arizona travel, and is helpful with respect to making travel plans. Subscribers feel the photographs in the magazine especially increase their interest in traveling in Arizona. About 35 percent of out-of-state subscribers who visited in the past five years indicated that AHM influenced them to visit Arizona on their most recent trip. Another 11 percent indicated they stayed some extra time due to AHM. In addition to its influence on visitors' decision to select Arizona as a destination, the magazine especially influenced decisions related to specific destinations or attractions and choices regarding travel routes. Subscribers have spent an average of over \$136.4 million annually over the

past five years, and \$34.7 million of those expenditures can be directly attributed to AHM and its influence on the travel behavior of out-of-state subscribers. Given AHM's annual cost of \$9.6 million, this amounts to a benefit/cost ratio of 3.6 to 1 at the very least.

Implementation: The research made two recommendations. Both have been successfully implemented by the Arizona Highways Magazine.

- (1) *Continue to fund and operate Arizona Highways Magazine.* AHM agreed to make efforts to retain the fund balance and reduce the amount and frequency of fund sweeps. AHM also agreed to seek to maintain the magazine's oversight by ADOT.
- (2) *Publicize the favorable benefit/cost ratio of the magazine's impact on bringing tourist dollars to Arizona.* The magazine's economic impact was a major peg in the promotional planning in support of the magazine's 80th anniversary activities and events in 2005. Further, a summarized version of the data will be included in "slug line" copy on all press releases for at least the next three years. Finally, a separate promotional campaign will be launched to underscore the economic importance of the magazine to the rural areas of the state that are unable to afford their own promotional efforts.

STRUCTURES

SPR-538: High Performance Concrete for Bridge Structures in Arizona

Project Cost: \$167,200

Summary: In order to stimulate the use of higher quality concrete in highway structures, the Federal Highway Administration has strongly promoted high performance concrete (HPC) materials. High performance concrete has been found to be feasible in all aspects of concrete bridges including the decks, piers, and pre-stressed concrete girder cross-sections. Several studies have indicated that using concrete compressive strengths of up to 10,000 psi (pounds per square inch) allowed longer span lengths and more economical structures. Many state agencies have thus saved construction time and money by using high performance concrete. One of the reasons HPC is not regularly specified for highway structures in Arizona may be the lack of available data regarding the field use in hot and arid climates. This research facilitated the use of high performance concrete in Arizona's bridges.

Implementation: In July 2005, HPC was poured on the deck of Sunshine Bridge in Holbrook, Arizona. Bridge decks are typically designed to last 50 years. However, due to the ice and salt used on the roads in the Holbrook area, which accelerated the deterioration of concrete, bridge decks life spans were often reduced to half the design

age. While the HPC costs 10% more than standard concrete, the return is a life cycle that is doubled and reduced maintenance costs are reduced as well. The research demonstrated that HPC can be used successfully on bridge decks. The research will also be used to develop new specifications for HPC and revise the method of bidding and paying these jobs.

TRAFFIC & SAFETY

SPR-451: *Pavement Marking and Signing Database*

Project Cost: \$103,155

Summary: The Arizona Department of Transportation maintains and manages an inventory of roadway signs. Before the implementation of this project, sign technicians maintained inventory records on individual laptops to track their daily sign maintenance activities. Each individual laptop contained sign file data that pertained only to the installed signs within the area in which the sign technician worked. It was difficult to share information and generate management reports. In addition, some sign regions did not even use their laptops to maintain the inventory records for their signs, but used paper forms to complete their daily work.

This research developed an application to:

- Track the installation, maintenance and replacement of all ADOT roadway signs
- Provide for the maintenance of data pertaining to the attributes of all ADOT roadway signs statewide, and
- Satisfy the dynamic business requirements, especially in the area of predicting sign replacement by allowing the database design to easily incorporate other factors into the prediction formula.

The image is a screenshot of a software application titled "Sign Management System - Version 2.0.5". The main window is labeled "Sign Summary" and contains several tabs: Summary, Activities, Signs, General, and Predictive. The "Summary" tab is active. The form contains the following fields and values: "Bar Code (or digit)" is 008405; "Responsible Org" is Tucson Sign & Stone; "Location" includes "Route" as I-10, "Link" as 209, "Roadway Location" as RIGHT, and "Direction From TL" as WGST; "Status" section shows "Active?" checked, "In Service Date" as 11/20/1994, and "Out Of Service Date" as 11/01/2003. There are also fields for "Longitude", "Latitude", and "Elevation" which are currently empty. The window has a standard menu bar with File, View, and Help, and a toolbar with icons for New Sign, View Sign, TI Runoff, Synchronize, Work Report, and Help.

Figure 2 Sign Screen Summary Tab

Implementation: The signing crews in the ADOT Traffic Group, which are responsible for interstate signs, and in Districts, which are mainly responsible for other state roads signs, are currently using the system on daily basis. The maintenance planning section

in the ADOT Central Maintenance group maintains the system. The sign crews use the Pavement Marking and Signing Database to keep track of all new signs added to the roadway and to track what they do (cleaning, fixing, etc) to existing signs on the roadway. As far as data population - there is still a lot of data that is not in the database. It is fed from FIS (Features Inventory System), the product of study SPR-474, *Development of a Statewide GIS-Based Features Inventory System (FIS)*, and FIS is not fully populated yet. Eventually, the Pavement Marking and Signing Database will be integrated into FIS, and the sign data will be fully populated.

Appendix A

List of Projects Completed During 2005

Project No.	Project Title
SPR-461	<i>Procedures for Winter Storm Maintenance Operations</i>
SPR-474	<i>Development of Statewide GIS-based Features Inventory System</i>
SPR-491	<i>Evaluation of the Cost Benefits of Continuous Pavement Preservation Design Strategies Versus Reconstruction</i>
SPR-496	<i>Effective Control Measures at High Particulate Pollution Areas: Analysis of Data from the 2002 Phoenix Greenwood Study</i>
SPR-512	<i>ITS Traffic Data Consolidation System</i>
SPR-518	<i>Arizona Department of Transportation Project Delivery Cycle Time Analysis</i>
SPR-530	<i>Critical Factors in the Development of Transit Systems in Rural Arizona</i>
SPR-550	<i>The Impact of Red Light Cameras (Automated Enforcement) on Safety in Arizona</i>
SPR-553	<i>Driver License Manuals Best Practices</i>
SPR-555	<i>Atmospheric Effects Associated with Highway Noise Propagation</i>
SPR-557	<i>Congestion Mitigation at Railroad-Highway At-Grade Crossings</i>
SPR-558	<i>High Risk Crash Analysis</i>
SPR-559(1)	<i>New, Improved, Comprehensive, and Automated Driver's License Test and Vision Screening System</i>
SPR-563	<i>Port Runners - Impacts and Solutions</i>
SPR-565	<i>Grand Canyon National Park and Northern Arizona Tourism Study</i>
AZ-596	<i>Technical Evaluation of Photo Speed Enforcement for Freeways</i>

Research: The relentless pursuit of excellence.

ARIZONA DEPARTMENT OF TRANSPORTATION

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